Creativity in Early and Established Career: Insights into Multi-Level Drivers from Nobel Prize Winners

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Abstract

The freedom to try new things plays a vital role for employees engaging in creative endeavors. This freedom can be influenced by one's relationship with her supervisor, relationship with her team, and various work pressures. One of the first steps to reaching creative output is to have a playful attitude towards work where there is encouragement and processes that allow individuals to take risks and try new things. However, we argue that what allows someone to try new things earlier in their career and when they are more established might be different. Noteworthy progress has been made in conceptualizing the multi-level factors that are important for creativity. In the current study we identified variables associated with a willingness to try new things, part of the exploration phase of creativity, and divided them by the early and established careers of 59 Nobel Prize winners. Using a historiometric approach, we rated individual and team level variables to identify what makes someone try new things either earlier or later in her career. Findings indicate that willingness to try new things is related to autonomy, the relationship with one's mentor, team climate, and team network, but not to personal initiative.

Keywords: creativity, career stage, levels of analysis, team, Nobel Prize

Innovation is the means to sustaining a competitive advantage (Amabile, 1988, 1996; Author, 2007), but innovation is incredibly expensive in terms of both time and money, mostly due to a high failure rate and high levels of risk involved (Mumford, Scott, Gaddis, & Strange, 2002). Thus, organizational leaders, especially those who are directly responsible for research and development activities, may be interested in understanding how to improve their return on investment for innovation. Likewise, people who are themselves involved in innovation and those who study innovative processes could benefit from a greater understanding of these processes.

Creativity, defined as the production of ideas that are novel and useful (Mumford & Gustafson, 1988), is a critical antecedent to innovation. Part of the early creative process is exploration (March, 1991) where individuals need to have a willingness to try new things. This playful sort of adventurous approach to work can be the result of multi-level influences. Personality may play a role, but other factors such as team dynamics, relationship with one's supervisor, work pressures, etc. may also be influential. We draw on the work by Rosing, Frese, and Bausch (2011) that discusses the role of ambidextrous leadership or switching from an exploration to exploitation framework to achieve creative outputs. This study focuses on these exploration or opening behaviors that generally occur early in the creative process as related to scientists trying new things. Opening behaviors generally foster exploration and involve breaking up routines and thinking in new directions. Rosing et al. (2011) define opening leader behavior as "a set of leader behaviors that includes encouraging doing things differently and experimenting, giving room for independent thinking and acting, and supporting attempts to challenge established approaches" (p. 967). This sort of climate would generally be encouraged if a leader wants employees to explore and try new things. Exploitation is related to streamlining ideas and focusing in on a specific course of action. This was defined by Rosing et al. (2011) as "a set of leader behaviors that includes taking corrective action, setting specific guidelines, and monitoring goal achievement" (p .967). We argue that various elements of exploration or opening behaviors will be related to trying new things in our study of Nobel Prize winning scientists. In this study we focus on a pragmatic kind of creativity – that which involves engaging with complex, ill-defined problems where the solutions are unclear (Ford, 2000; Mumford et al., 2002; Reiter-Palmon & Illies, 2004). This sort of problem would generally require a significant period of "testing things out" in order to arrive at an appropriate solution. Studying interviews and autobiographical material with scientific Nobel Prize winners allows us to examine multiple factors and processes that lead to a willingness to try new things at work. Our study makes a contribution to the creativity literature and research and development contexts more generally in the following ways. First, we investigate what allows this early exploratory phase of creativity to occur by observing the multi-level factors that can lead an individual to try new things. Next we study how these factors may differ across an individual's career. For example, are there certain elements that need to be in place for an individual to explore and try new things early in their career but are perhaps different once they are more established in their career?

Research indicates that creative outcomes are impacted by multi-level factors such as job characteristics, organizational resources, support, and education (Mumford, Hunter, & Bedell-Avers, 2008; Shalley & Gilson, 2004). Team dynamics are also important with research indicating that teams are more creative when they perceive their work requires creativity, as well as having shared goals, high task interdependence, participative problem solving, and a climate supportive of creativity (Gilson & Shalley, 2004). However, despite the apparent breadth of factors that support creativity, previous research has largely overlooked how these factors will impact an individual's general willingness to try new things at different stages of one's career. Without this willingness to try new things, one could argue that creativity and innovation will suffer. Given these somewhat limited findings, an important question to ask is what types of factors may lead to individuals trying new things either early or later in one's career? One way to address this question is by examining the multi-level factors that could play a role in trying new things in a scientific context, which in turn can lead to creativity and innovation.

Explicit consideration of levels of analysis is important for two primary reasons (Yammarino, Dionne, Chun, & Dansereau, 2005). First, failure to consider levels of analysis leaves theory building and theory testing incomplete, and may lead to incorrect conclusions. For example, Silvia (2007) has suggested that much of the early creativity research may be flawed because it typically did not examine the possible effects of having a nested data structure. Second, consideration of different levels of analysis may provide important insights. For example, Yammarino et al. (2005) pointed out that a revolution occurred in physics when physicists proposed, and subsequently demonstrated, that quantum mechanics operate at a level *lower* than the atomic level. In this paper, we examine the impact of creative climate at three levels of analysis (individual, team, and organizational) on an individual's willingness to try new things across early and established career stages of 59 Nobel Prize winners in physics, chemistry, medicine, and economics.

Literature Review and Conceptual Development

Background in creativity research

A significant body of research has been conducted on the topics of creativity and innovation. This research appears in a variety of fields and publications, from engineering to human resources to interdisciplinary studies specific to creativity. Just as the context of this literature is diverse, so is the methodology employed. For example, some research relies on recognized scientists as the sample (Simonton, 1991, 2003; Zuckerman, 1996) and other research studies creativity through lab studies (Beeftink, van Eerde, & Rutte, 2010; Curseu, 2010; Rastogi & Sharma, 2010), while still other research explores organizations where creativity occurs, such as information technology or research and development firms (Zhang & Bartol, 2010).

There is noteworthy research that investigates both the processes of creativity (e.g., Amabile, 1996; Lubart, 2001) and innovation (e.g., Staw, 1990), as well as identifying various predictors of creative and innovative behaviors and outputs (see Anderson, De Dreu, & Nijstad, 2004; Egan, 2005; Madjar, 2005; Zhou & Shalley, 2003 for reviews). Early research on creativity was based on the premise that creativity was primarily determined by stable traits (see Barron & Harrington, 1981; Feist, 1999 for reviews). Although personality may play a small, albeit significant, role in creativity, team and organizational factors may play a more significant role. Scientists do not act in isolation; rather, they generally work in teams and are part of a larger scientific community to which they have access (Crane, 1972); therefore, scientific creativity must be studied at multiple levels (Hennessey & Amabile, 2010). Thus, these multi-level variables, such as team dynamics and organizational-level resources, should also be considered when attempting to understand what allows a creative scientist to achieve eminence. Before an individual can obtain that creative output that leads to their eminence, they need to be in a climate where they can have a playful approach to work and try new things (Sullivan, 2011). We argue that trying new things is important across the span of a work career. However there may be different variables that lead to this willingness to try new things based on career stage. Our list of potentially important variables was informed by the vast amount of research that has been conducted on creativity (e.g., Mumford et al., 2002; Shalley & Gilson, 2004; Shalley, Zhou, & Oldham, 2004). This prior research, while quite robust, has not considered the impact of career stage in conjunction with factors at multiple levels of analysis.

There is, however, a significant body of work examining creativity across the lifespan. This research tends to examine issues such as the influence of early life experiences

(Simonton, 1984) or modeling creative career trajectories (Simonton, 1997) to examine how creativity varies as a function of chronological or career age (Simonton, 1988) or expertise (Kozbelt, 2008). The present study takes a different approach by focusing on the relative importance of various factors on the approach to exploration at different stages of one's career.

Two key forms of organizational learning that are important to innovation, exploration and exploitation, were defined by March (1991). Exploration is related to experimentation, searching for alternatives, and risk taking, while exploitation is related to adherence to rules, alignment, and risk avoidance (March, 1991). While both are arguably important for creativity and innovation (Rosing, Frese, & Bausch, 2011), we focus our attention on the exploration phase. Exploration has been noted to be an important characteristic of research and development teams (Chandrasekaran & Mishra, 2012). While both exploration and exploitation may be important to innovation, an emphasis on exploration had been found to be important by some researchers (Zahra & George, 2002; Cohen & Levinthal, 1990). Others have argued that a balance between exploration and exploitation lead to the most positive performance (Katila & Ahuja, 2002; He & Wong, 2004). Additionally, explorative activities may be more important at the beginning of the innovation process (Cheng & Van de Ven, 1996). Examples of opening leader behaviors that might encourage exploration include: allowing different ways of accomplishing a task, encouraging experimentation with different tasks, motivating to take risks, giving possibilities for independent thinking and acting, giving room for own ideas, allowing errors, and encouraging error learning (Rosing, et al., 2011).

In the current study, we focused upon scientific Nobel Prize winners, given that such an award represents international recognition of achievement at the highest possible level and can clearly be interpreted as proof of a creative contribution. Scientists were selected because they generally work in teams and are part of a larger scientific community. Winners of Peace and Literature prizes do not work in the same team-based way with strong mentoring relationships. For this reason, the Peace and Literature domains were not included in this study. While certainly all of the scientists who have won a Nobel Prize will have enjoyed significant recognition by his or her peers as well as respect within the scientific community due to some noteworthy contribution, there are differences in the ways that these individuals went about earning this achievement. Similarly, while creativity can be viewed either as incremental improvements or major breakthroughs (Mumford & Gustafson, 1988), the context of this study is on individuals who achieved a major breakthrough for which they were then awarded the Nobel Prize. Earning the Nobel Prize is an indication that the individual has successfully engaged in structuring a problem and generating a solution to a complex, ill-defined problem of significance. To successfully accomplish this, an individual needs to be willing to take risks and try new things. However, this approach to work may differ in early versus established career because of additional responsibilities, reputation (trying to build or maintain), etc.

Early in one’s career, the relationship with the mentor and graduate school cohort is important, while later in one’s career, scientists will likely become the mentor themselves and maintain relationships with former students. Erickson (1968) described the idea of generativity that happens in established career stages as individuals try to extend his or her work by mentoring younger colleagues. Although earlier research has described three career stages (early, mid-career, and late; Super & Bohn, 1970), the current study simply distinguished between early and established career stages. The reason for this was that the mid-career can be of differing lengths for individuals. Thus it is fairly difficult to determine the precise entry point into established career across a large group of scientists. It is much clearer to have early career represented as the PhD and postgraduate experience and established career represented as being firmly in a work role (academic or industry). In sum our "established career" covers mid and late career.

Specifically, for the purposes of this study, we conceptualized early career as the time when the winners were in graduate training through their first full-time position. Established career included the time from their second job through the end of their career. All of the winners in our sample had a second job that they moved into, so there were no instances of anyone staying in their first job throughout their entire career. Although these timeframes are not equal in terms of number of years, they illustrate the career stages that were prominent in the interviews that we coded of the 59 Nobel Prize winners. The early career stage is characterized by a learning relationship with the mentor and the graduate school cohort, and also includes the first major transition experienced by the scientist as he or she assumes autonomy and moves to establish a research path. The established career timeframe is characterized by assuming research grants and generally building a research community at the home institution.

The actions (e.g., trying new ideas, processes, and seeking different goals) that lead to producing creative outputs is, along with taking risks, the *sine qua non* of creativity (Shalley & Gilson, 2004) because, by definition, creativity involves generating novel solutions. Further, in their interviews and autobiographies, many winners mentioned the importance of being able to try new ideas and new processes as the key driver of their success. Thus, based on both prior research and the words of the scientists themselves, we focused on trying new things as our primary outcome.

Individual level predictors: Creative characteristics

Significant research has been conducted on the effects of personality on creative outputs. A recent meta-analysis identifies two personality factors, creative personality and openness to experience, as having a significant relationship with individual creative and innovative behavior (Author, 2011). In fact, the Creative Personality Scale (CPS) developed by Gough (1979) attempts to provide a measure of creative potential. Individuals scoring high on this measure are supposed to approach novel problems with broad interest, possess self-confidence, tolerance for ambiguity, patience with competing ideas, and persistence in developing a creative idea. Although many factors contribute to creative behavior, the importance of personality variables on creativity and innovation should not be underplayed. Research also indicates relationships between aspects of the Big Five measure and creative output, particularly openness to experience (e.g., Batey, Chamorro-Premuzic, & Furnham, 2010; Feist, 1998, 1999; Raja & Johns, 2010). Other research by McCrae and Costa (1997) argues that those individuals that have a tendency to combine divergent pieces of information also have a tendency to seek out novel, unfamiliar situations. It is the exposure to these unfamiliar situations that continues to allow these individuals to pull together divergent pieces of information.

In addition to personality, the relationship with one's leader can influence creative climate. The way that a leader interacts with followers can influence how the follower approaches work. Leader control (autocratic) generally harms creativity, encouraging voice and involvement (participative) promotes creativity, and giving trust and autonomy (free reign) promotes creativity (Amabile, 1998; Friedrich, Stenmark, & Mumford, 2011; Yukl, 2009). Essentially, we would expect that when a leader gives more freedom to followers, they are more likely to try new things. This may simply be because they have more autonomy or it may be that they feel higher levels of intrinsic motivation to try new things because they feel more ownership over the task when their career is established. Data collected from research and development organizations by Hall and Mansfield (1975) found that the early career stage was characterized by low job involvement, low intrinsic motivation, low need for security, and high need for self-fulfillment. These findings were also consistent with earlier work on career stages by Super and Bohn (1970). In contrast, Hall and Mansfield (1970) found that established career was characterized by high concerns for security, increased involvement in the job, higher intrinsic motivation, but lower concerns for self-fulfillment and autonomy. Similarly, these findings were consistent with research conducted by Super and Bohn (1970). There is less concern for self-fulfillment and autonomy in later career because it is likely that individuals have already reached a point professionally where they are more autonomous and fulfilled than they were earlier in their careers. Since people generally have more autonomy and intrinsic motivation later in their careers, it is perhaps those individuals that possess these attributes early in their careers that may feel more freedom to try new things and in turn may stand out.

Creative-relevant personality traits have been found to co-vary with early creative success (both measured at age 27) as well as lifetime creative success (measured at age 72) above the effects of observer-rated potential and intelligence (Feist & Barron, 2003). Although some variation occurred in the predictive capacity of various personality traits, generally relationships were stronger between personality and early creative output. As such, it is likely that influence of autonomy and personal initiative will be stronger in early career versus established career because there are fewer intervening variables, such as having an expansive network or other work commitments, at that time. Early in one's career there is more reliance on oneself and one's own initiative in terms of trying new things to break away from the more directive instructions of the supervisor. Also, during early career, network, career goals, and commitments are not as firmly established as they are later in one's career. Thus, we have our first hypothesis.

H1: Autonomy will be more strongly related to trying new things in early career than established career.

H2: Personal initiative will be more strongly related to trying new things in early career than established career.

Dyad level predictors: Mentor relationship

Leadership plays an important role in the creative environment. Several studies have focused on the role of the leader in fostering innovation (e.g., Author, 2010; Author, 2007; Mumford, Scott, Gaddis, & Strange, 2002; Shalley & Gilson, 2004). A study of 191 R&D employees of a large chemical company by Tierney and colleagues (1999) explored the influence of Leader-Member Exchange (LMX) and creative performance. The results of this study indicated that the interaction between employee cognitive style and LMX influences levels of creative performance. This study found that just because someone has the ability to be creative does not mean that he/she will be inclined to be creative. There are motivational elements as well as the actions of the leader that foster creativity and innovation. This was clearly demonstrated in the work by Zhang and Bartol (2010) when they looked at the role of empowering leadership and the subsequent intrinsic motivation on employee creativity. They found that empowering leadership positively affected the psychological empowerment of employees, which together influenced the levels of intrinsic motivation among employees and resulted in the engagement of creative processes.

The relationship that an individual has with his or her mentor is the foundation for forming views toward the profession, understanding of norms, etc. In a study by Mumford, Murphy, and colleagues (2007), the authors identified the following variables as having a noteworthy influence over decision-making in one's early career: professional leadership, poor coping, lack of rewards, limited competitive pressure, and poor career direction. Many of these variables can be influenced by the mentor or supervisor. Years ago, it was noted that Nobel laureates were likely to have studied under prior award recipients (Zuckerman, 1996); however the reasons for this have not been explored. Further, Simonton (1992) found that psychologists produced their first highly cited piece earlier in their career when they worked with a distinguished mentor and attended distinguished graduate programs. Because of this, it is likely that mentors play significant roles early in one's career.

H3: Having a positive mentoring relationship will be more strongly related to trying new things in early career than established career.

Team level predictors: Team dynamics

From the meta-analysis conducted by Hunter, Bedell, and Mumford (2007), we know that climate plays a key role in the creative output of an individual. The extensive literature on effective group processes has identified various practices that can impact a group's ability to perform effectively. Team dynamics involve the internal group process elements that members of a team engage in. Researchers have identified these processes as involving elements such as task interdependence, task design, team characteristics, and team attitudes, all of which influence team effectiveness (Cohen & Bailey, 1997). Variables such as positive peer group, positive interpersonal exchange, intellectual stimulation, and participation indicate the importance of the team to engage in creative endeavors.

Teams in particular play an important role in creativity and are seen as increasingly responsible for the work that is performed in organizations (Sundstrom, 1999). Team processes that have been associated with creativity include: involving others, addressing conflict, and communicating effectively (Taggar, 2001). In looking at the team characteristics related to creativity, Gilson and Shalley (2004) found that indicators included having high task interdependence, taking on tasks requiring high levels of creativity, possessing shared goals, valuing participative problem solving, having a climate supportive of creativity, and socializing in and outside work. The study established that individuals on more creative teams had a stronger tendency to socialize and had moderate amounts of organizational tenure. This establishes the importance of one's network. While one's network is likely to have a different make up in established career than it does in early career, we argue that it is equally as important across career stage. Early in one's career, the network may be fairly narrow, consisting of fellow graduate students and a handful of individuals met at conferences. Once one's career is established, the network consists of graduate school contacts, current colleagues, and a much wider group of individuals met through conferences or editorial boards. This may consist of increasingly diverse and developed networks of colleagues, increased levels of expertise, and additional responsibilities that come with tenure. Early studies involving research scientists indicate that individuals are focused on establishing themselves as professionals in their early careers (Glaser, 1964). Thus, we suggest:

H4: Networks will be related to trying new things in early and established career.

H5: Team climate will be related to trying new things in early and established career.

While previous research has identified these various contributors to the creative process, to our knowledge little research has examined the relative importance of each one in the creative process. This dearth of research extends to a consideration of these factors at different career stages. Still, we think that it would be helpful to have some evidence of the relative importance of these factors. As such, we offer the following research question:

RQ1: What is the relative importance of autonomy, personal initiative, a mentoring relationship, a strong network, and team climate for trying new things in early and established career stages, respectively?

Method

The processes involved in creative endeavors are extremely difficult to observe. For this reason, a historiometric approach as described by Simonton (1991, 2003) was used to allow for observation and evaluation of the multi-level phenomenon at play among highly creative individuals, in this case Nobel Prize winners. Historical research can allow one to observe behavior from a more objective perspective. Because of the high-level nature of this sample, video interviews and autobiographies were determined to be the best source materials. This approach has been used in research studying various behaviors or cognitions of high-level leaders (e.g., Author, 2010). There are many complexities involved that would make laboratory studies difficult (Mumford, 2006; e.g., capturing multi-level phenomena and ecological validity), and similar problems arise when studying high-level creative individuals through surveys. A historical sample of Nobel Prize winners is an appropriate sample for the study of creativity, particularly since we were able to study these creative individuals across the domains of economics, medicine, chemistry, and physics. Because we were particularly interested in individuals who developed a specific solution to a complex, ill-defined problem, the individuals receiving science awards were of interest. We were also interested in creativity at multiple levels and scientists generally work in teams and are part of a larger scientific community. For these reasons, Peace and Literature were not included in the sample. Using historical documents in the form of video interviews and autobiographical articles provided access to this population along with the observation and assessment of perceptions of their experiences.

This historiometric approach involves the content analysis of historical records, as described by Simonton (1991, 2003), allowing for examination of these complex interactions and relationships in their historical context. Historiometric research within the domain of leadership has advanced our understanding of complex phenomena (Ballard, 1983; Hermann, 1980; House, Spangler, & Woycke, 1991; Mumford, 2006; O'Connor, Mumford, Clifton, Gessner, & Connelly, 1995; Winter, 1993), allowing a wide range of research questions to be addressed. When designing a historical study, the sample and data source must be carefully considered to ensure a well-developed, rigorous historiometric study. Accordingly, a selection plan was developed for the sample and data source.

Sample and Data Source

Sample. Specific criteria were developed for the selection of the Nobel Prize winners to be included in this study. Initially, we identified 100 winners from economics, medicine, physics, and chemistry. This list was then reduced based on the length of the interview and the availability of the markers of interest (e.g., in some interviews the winner only discussed technical topics which were specific to his or her scientific field). Finally, a list of 59 leaders was established (see Table 1 for a complete list) based on the following criteria: 1) he or she won a Nobel Prize in economics, medicine, physics, or chemistry, 2) there was an autobiography in an annual review piece for an academic journal or there was a video interview conducted by nobelprize.org, and 3) the article or interview was an appropriate length to cover the relevant markers (approximately 30 minutes or 20 pages, respectively). Roughly equal numbers of winners in economics, medicine, physics, and chemistry were identified to allow us to observe differences based on field of research.

Insert Table 1 about here

Winners were selected from several countries to account for cultural differences that may occur in the creative process. Similarly, winners from different time periods were selected. For example, someone at the height of his or her career during a major world war may have a different experience from someone at the height of his or her career during an economic boom. Included in the sample were leaders who won Nobel Prizes between the years of 1939 and 2007.

Data Source. Autobiographies were selected from annual review articles appearing in academic journals. These were found by conducting a search through an electronic library system. In addition to this, economics autobiographies were found in a book called *Lives of Laureates - Thirteen Nobel Economists*. Interviews were selected and viewed on nobelprize.org. The criteria used to select the articles and interviews for inclusion in the study were as follows: 1) the article or interview took place within the past 50 years (our sample included interviews that spanned the years 1961 to 2009) and 2) the article or interview contained a discussion of the relevant markers. Both articles and interviews were selected because without this inclusion our sample size would be limited. The entire article or interview was read or viewed to assess the relevant markers developed for this study. We determined that autobiographical information in written form and elicited through interviews was the best source material for this study because of the unique experiences of these individuals and the potential difficulty in gaining enough detail in a biography. For example, it would be difficult for an outsider to understand the intricacies of the graduate school experience of a Nobel Prize winner. Although there are clearly biases associated with self-reported material, we believe that this is the most accurate way of comparing the unique perceptions of these scientific leaders.

Predictors and Criteria. After conducting a literature review on the relevant aspects of scientific creativity and initial reading of the source material, two academics in business schools created event markers based on prior creativity research (e.g., Mumford & Gustafson, 1988; Shalley & Gilson, 2004), to be evaluated on a 5-point Likert scale. Each marker was evaluated on a five-point scale with 1 being “not at all” and 5 being “to a great extent”. The literature review coupled with appraisal of autobiographies and interviews allowed for inclusion of markers capturing components both at early and established career as well as individual, dyad, group, and organizational levels of analysis. These markers were written to assess observable behaviors that consistently appeared in the autobiographies or interviews. Separate markers were written to capture the essence of each area of interest. These areas included 1) individual (e.g., “To what extent does the scientist display inquisitiveness related to his/her research area in childhood?”), 2) leadership in established career (e.g., “To what extent does the scientist through leadership actions, create optimal resources to complete tasks?”), 3) role of the mentor in early career (e.g., “To what extent does the scientist have a high quality exchange relationship with their mentor?”), 4) team or work group in early career (e.g., “To what extent does the scientist have task interdependence with work group members?”), 5) team or work group in established career (e.g., “To what extent does the scientist have diversity in his or her network?”), 6) organization in early career (e.g., “To what extent dos the scientist have participative safety (within the organization)?”), and 7) organization in established career (e.g., “To what extent is the scientist free from extraneous concerns?”). A total of 75 predictor markers were developed. Approximately 15 items were written to capture aspects of each level and stage of career. The criterion measure was similarly assessed by asking the question, “To what extent is the scientist able to try new things?” (in early or established career, respectively). For the current study, we focused on only a sub-set of the available markers as warranted by extant research relating career stage at which creativity occurs. Other marker sub-sets will be used to address other research questions. A complete list of items used in this study may be found in Table 2.

Insert Table 2 about here

Controls. In addition to the predictors and criteria, controls were developed to account for situational variables, characteristics of the autobiography or interview, and individual characteristics that may otherwise influence the criterion variables. The information to assess the controls came from nobelprize.org, the annual review articles, or the book *Lives of Laureates – Thirteen Nobel Economists*. Several variables were included that were anticipated to account for variation among the variables of interest. Several control variables were selected following the historiometric research methodology conducted by Mumford (2006). For example, variables about the autobiography or interview such as length and nature of media were used. Control items such as age of winning the prize, country of origin, country where living, etc. were included. We also controlled for the domain of each winner (physics, chemistry, medicine, and economics).

Rating Procedures

Five judges completed the ratings, all academics in business schools researching organizational behavior. All judges have an understanding of leadership, psychology, and creativity and publish frequently in one or more of these topic areas. They engaged in a 40-hour training program where they were asked to assess predictor and criteria items based on the creativity literature on a 5-point Likert scale. In the first meeting, the markers were discussed and agreement was reached for what would constitute a low, medium, or high rating for each marker. Next, individuals were assigned two scientists to rate for all of the markers. Then, the judges met again to discuss their ratings. If there were differences of two points or more between ratings, then the judges discussed the scientist and marker until agreement could be reached. Because there were several items where there was initial disagreement, the process was repeated and judges independently rated the markers for two more scientists and discussed their ratings. Finally, 10 of the scientists were rated by all the judges and inter-rater reliabilities were calculated. After being exposed to this training, the average inter-rater agreement coefficients for these items was adequate (ICC =.79) using the procedures suggested by Shrout and Fleiss (1979). Each of the 59 winners was evaluated by at least four raters, with 14 winners being evaluated by all five raters. As such, individual ratings were averaged to provide a single score for each of the 59 winners for every marker. Finally, markers were combined to form variables to test the hypotheses. For example, the nine markers that assessed mentorship were combined as reflexive indicators into an overall mentorship variable.

Results

Analyses

We first conducted preliminary analyses (examining correlations and regressions) for the various control variables. Results from both approaches revealed that none of the controls had a statistically significant effect on the outcome; therefore, we excluded them from the test of the theoretical model. For testing of both the measurement model and the theoretical model, we utilized Partial Least Squares (PLS) analysis using *SmartPLS* (Ringle, Wende, & Will, 2005). PLS is widely used for exploratory data testing and has several advantages over other techniques (Chin & Newsted, 1999). PLS does not require multivariate normal distribution and is especially suitable for the analysis of small samples. Moreover, PLS can help to reduce measurement error by weighing the individual indicators of a multi-indicator variable (Sosik, Kahai, & Piovoso, 2009). Other forms of path modeling, such as covariance-based structural equation modeling, are generally used in confirmatory model testing and may be susceptible to error in situations where there is a low construct-to-sample size ratio, as was the case in this study. PLS also has the ability to test both the measurement model and theoretical model simultaneously. This ability makes PLS preferable to multiple regression analysis in which the measurement model and theoretical models must be tested independently.

The test of the measurement model includes three primary parts: 1) individual item reliability, 2) internal consistency, and 3) discriminant validity. Tables 2 and 3 include results for all three parts. Individual item reliability was assessed by examining the factor loadings of each measure on its corresponding construct. Fornell and Larcker (1981) suggest accepting items that have more explanatory power than error variance. In practice, the generally accepted cutoff is .70 or greater, but in exploratory research this standard is often relaxed to .50. Although the current research is exploratory in nature (specifically, although all items have been identified in previous research, grouping according to level of analysis and/or career stage is exploratory), we elected to use a more conservative approach and to keep all factors with factor loadings of .60 or greater. Using this standard, we eliminated one item from Team Climate – Early Career and Team Climate – Established Career (i.e., "to what extent does the scientist socialize with members of the work group?").

Insert Tables 2 and 3 about here

Construct internal consistency may be assessed by composite internal scale reliability, which is similar to Cronbach's alpha. Fornell and Larcker (1981) suggest a cutoff of .70 for internal consistency. Internal scale reliability in this study was quite robust for all variables (ranging from .82 to .95). A second way to measure internal consistency is with Average Variance Extracted (AVE), which is a measure of variance accounted for by the underlying construct. Fornell and Larcker (1981) suggest a cutoff of .50 for AVE, and the AVE for all variables in this study was acceptable (ranging from .62 to .82); thus, internal consistency appears to be adequate.

Discriminant validity in PLS is assessed in two ways. First, each item should load higher on the construct that it is supposed to measure than on any other construct (Carmines & Zeller, 1979). All items in the study met this criterion. Second, each construct should share more variance with its items than with any other construct in the model (Barclay, Higgins, & Thompson, 1995). This criterion is usually assessed similarly to a multi-trait/multi-method approach. Specifically, the square root of the AVE of a construct should be greater than the construct's correlation with any other construct in the model. An examination of Table 3 (in which the square root of the AVE is located on the diagonal) demonstrates that this criterion was also met.

Results of the test of the theoretical model are shown in Table 4. The standardized beta coefficient for each path in the model was obtained from the PLS algorithm in *SmartPLS*. Statistical significance of each path in the theoretical model was determined by the t-value for a given bivariate relationship based on a bootstrapping technique with 1,000 iterations.

Results showed that autonomy was related to trying new things in both early career ($b = .25$, $p < .05$) and established career ($b = .22$, $p < .05$). Results of the analysis of relative importance through dominance analysis (see below) showed that autonomy in early career explains marginally more variance (.11) than in established career (.08); thus, Hypothesis 1 was supported. However, personal initiative was not related to trying new things in either early ($b = .04$, *ns*) or established ($b = .03$, *ns*) career; thus, Hypothesis 2 was not supported. Both autonomy and personal initiative are individual-level variables. Given these results, it appears that autonomy is more important than personal initiative for Nobel Prize winners. As Kary Mullis, Nobel Prize in Chemistry 1993 stated, "*one of the good things was […] they said you should do whatever you want to do. Then if you wanted some equipment you didn't have to wait for it.*"

Next, having a strong network appears to be important at both career stages, as early career network was related to trying new things in early career ($b = .32$, $p <.05$) and established career network was related to trying new things in established career ($b = .33$, $p < .05$); thus, Hypothesis 4 was supported. Team climate was related to trying new things in both early ($b = .48$, $p < .05$) and established ($b = .38$, $p < .05$) career; thus, Hypothesis 5 was supported. Having a network of people to develop fresh ideas and having a climate that allows for openness, exploration, and inquisitiveness are both important throughout one's career.

This was expressed by George Olah, Nobel Prize in Chemistry 1994, when he stated "*For any scientist it is essential to have contact, free exchange, as we said kicking around* *ideas."* Perhaps the clearest depiction of the importance of established networks in the later career is that of Frederick Sanger who was awarded two Nobel Prizes in Chemistry (1958 and 1980). He stated that "*If you already have a prize then you can get facilities for work and you can get collaborators and everything is much easier ... perhaps I was lucky in that I got my first prize when I was rather young … I had 20 years then to do what I wanted to do."*

Having a team that allows for openness, exploration, and inquisitiveness is important throughout one's career. Placing mental restrictions on a person at any career stage is detrimental to creativity. The need to have a broad focus and "*play around"* as one of the interviewees stated is illustrated by the following quote*: "I got a little sidetracked, I was, a little going into biology, but then immediately the DNA was so important and then the physicist in me took over again … trying to combine physical sciences, with biological sciences with engineering"* (Steven Chu, Nobel Prize in Physics 1997). John Polanyi, Nobel Prize in Chemistry 1986, echoes this by saying that "*any scientist jumps over these alleged boundaries and values doing so.It is by practicing and playing that you develop ideas and theory is only really your back-up … mostly it is an intuitive thought that starts it...the gut-feeling. In my own work I like to be able to improvise quickly"* (Theodor Hänsch, Nobel Prize in Physics 2005). This was described well by George Olah, Nobel Prize in Chemistry 1994, who describes the importance of always having free exchange of ideas with one's students in a nurturing environment in that "*Your students are your wider scientific family."*

Results showed that having a relationship with a mentor was marginally related to trying new things in early career ($b = .28$, $p <.10$) but not in established career ($b = .12$, *ns*); thus, Hypothesis 3 was marginally supported and points in the direction that mentorship is more important earlier in one's career. We note that the *b* weight for early career is sizeable and approaching significance, but that the relative importance is rather modest (.03); thus, the marginal support for Hypothesis 3 should be interpreted with caution.

We also examined the relative importance of each predictor variables using dominance analysis (Budescu, 1993; Tonidandel & LeBreton, 2011). Dominance analysis is a statistical technique that partitions the total variance explained by each individual predicator variable. When predictor variables are correlated (as in this study), traditional standardized regression weights are not suitable for addressing questions of relative importance because they do not partition the variance explained by each predictor. According to Tonidandel and LeBreton (2011), dominance analysis addresses this problem by "examining the change in R^2 resulting from adding a predictor to all possible subset regression models. By averaging across all possible models…one obtains a predictor's *general dominance weight*" (p. 3).

Results from the dominance analysis of relative importance (Table 4) show that, generally speaking, autonomy is slightly more important in early career (in support of H1), having a strong network is the overall most important predictor and remains relatively constant in both early and established career, and the relative importance of team climate increases in importance into established career. These findings are discussed in greater detail below.

Discussion

Limitations

Before turning to the implications resulting from this study, we will acknowledge some limitations. First, this study relies on an elite sample, Nobel Prize winners, which may make it difficult to generalize to a broader population of research scientists. However, we believe that by studying some of the best innovators of our time, we are able to improve our understanding of what allows someone to have such a large creative impact. Also, while this is an elite population, results from this study could be generalized to scientists working in research and development areas both in industry and academia with industry affiliations. Second, also related to the sample, is the fact that the material used in this study was restrictive in the sense that the only information available was that which was provided in the autobiography or interview. Because of this, the sample was winnowed down based on those autobiographies or interviews that contained a substantial discussion of information captured by our markers.

Also, there was overlap between the two individuals that designed the conceptual framework for the variables of interest in this study and conducted the ratings. Therefore there is a potential for single source bias. Attempts were made to reduce this potential bias by having discussions about the variables of interest between all judges and providing several rater training sessions. While we were unable to have face-to-face rater training sessions, we were able to conduct several rater training sessions using Skype until we were all satisfied with our shared interpretation of the markers.

Finally, there was not a clear split in terms of number of years for early and established career; however, we did find a clear dividing point that was used across all scientists in the sample. We thus conceptualized early career as the time when the winners were in graduate training through their first full-time position. This phase was characterized by having a dependence on a mentor and graduate school cohort. Established career included the time from their second job through the end of their career. This phase was characterized by establishing independence as a researcher and moving into the role of the mentor. Because these phases are clearly delineated and map to distinct career stages – early career is mapped to stage 1 and established career is mapped to stage 2 and 3 (Super & Bohn, 1970) – we feel that this categorization was appropriate.

General Findings

Even though there are some limitations, we still believe that there are strong contributions resulting from this work that advance our understanding of creativity and innovation. In this study, we have identified the factors that impact trying new things during different career stages. These findings add to the body of knowledge on lifetime creativity by highlighting the relative importance of various predictors at different career stages. Interestingly, trying new things appears to occur independently of field (economics, medicine, chemistry, or physics). First, autonomy appears to be important in early career. This is likely because individuals in general have increased autonomy when they are established in their careers so it does not create such an advantage as it does if individuals are fortunate enough to have it early in their careers. Next, network and team climate were found to be important both in early and established career. As scientists develop experience and work closely within their supportive networks, they identify what allows them to try new things and can therefore be more deliberate in creating an environment that supports trying new things in their established careers.

Theoretical Implications

The theoretical implications are threefold. First, autonomy paired with a strong mentoring relationship is important early in an individual's career. In terms of personality characteristics, it was particularly beneficial if the individual displayed independence of judgment and autonomy. This is an interesting combination of variables that clearly illustrates the importance of an independent mind and willingness to take on a challenge.

Second, realizing that not only personality characteristics play a role in whether an individual tries new things has implications for mentors as well as organizations as they frame educational and working contexts for these individuals. Thus, also important to the early career was the mentoring relationship. It was determined that the mentoring relationship should be supportive and open in nature where frequent feedback and evaluation were provided. This type of relationship most likely allows early career individuals to feel free to explore and try new things because they feel somewhat protected by the expertise and experience of the mentor.

Individual level variables and the nature of the mentoring relationship clearly play an important role in an individual's desire to try new things early in his or her career. While later in one's career, an individual has a much more extensive network from which to receive feedback and explore ideas, the mentoring relationship early on is particularly important. Our research indicates that in essence, individuals need to have a certain set of individual characteristics that allow them to have an independent mind ready to tackle a challenge. Coupled with this, a supportive and guiding mentor allows early career researchers to try new things freely.

Third, we have a better understanding of the importance of team dynamics in willingness to try new things. Not only are they important early in one's career, but they remain important during the established career. One's network as well as the team climate are important variables that allow an individual to try new things both in early and established career. It goes to follow that individuals who have a broad network made up of creative individuals will maintain this network later in their career, thus allowing them to continue to try new things in their work environments. Similarly, team climates that are characterized by a positive, safe, participative nature will feel encouraged to try new things whether they are just starting out or they are established in their careers.

Practical Implications

This research has implications for those managing research and development projects in industry as well as research environments. As we have been able to identify specific variables that impact creative outputs in both the early and established career stages, we can appropriately direct the investment that managers make in the careers of scientists.

Our results can also be used to structure environments in such a way that individuals are willing to try new things. This has implications for individuals that are currently in PhD programs, as knowing what can lead to success can empower them to seek out the most appropriate context. In addition, advisors can be aware of what may foster the most conducive environment for creativity to occur. Lastly, those in industry can consider context as they are structuring their environments. When early career scientists are brought into an organization, not only can they select employees based on some of the individual level variables that were determined to be noteworthy, they can provide a structure at a group level to allow these early career scientists to flourish.

Finally, it is clear from our findings that professional networks are critically important for scientists in terms of trying new things regardless of career stage. Having a broad and diverse network can bring in new ways of looking at a problem that can allow an individual to approach a situation with a fresh perspective. This is important not only early in one's career, but also in established careers, so an exploratory, fresh, playful approach to solving a complex ill-defined problem remains a core part of a scientist's work life.

Future Research Directions

Future research on individuals working in research and development will help to solidify the understanding of the various pathways to a successful scientific career. While the current effort provides substantial information about trying new things in early and established careers, conducting research on a broader population working in research and development would provide a more generalizable portrayal. While the current study was focused on the exploration phase of creativity, it might be useful to see how exploitation fits into the equation for scientists.

In sum, creativity and innovation will continue to be an important part of our economy where ideas hold immense monetary value and potential societal impact. The investment in this life-blood of a knowledge economy is also becoming limited as we manage through a global economic crisis. Investment in creative endeavors therefore needs to be targeted and we need to know which factors can influence an individual being able to try new things and engage in the creative process. This study allows us to understand what variables allow individuals to maintain an exploratory, playful approach to work across the span of their careers.

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Table 1.

Nobel Prize Winner Information

Name	Field	Year of Nobel Prize	Country of Birth	Reference
Steven Chu	Physics	1997	USA	Smith A. (Interviewer) & Chu S. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1079
Roy J. Glauber	Physics	2005	USA	Smith A. (Interviewer) & Glauber , R. J. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1103
Theodor W. Hänsch	Physics	2005	Germany	Smith A. (Interviewer) & Hänsch, T. W. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1076
Heinrich Rohrer	Physics	1986	Switzerland	Smith A. (Interviewer) & Rohrer H. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=979
Gerardus 't Hooft	Physics	1999	Netherlands	Carlson P. (Interviewer) & Hooft G. (Interviewee). (1999). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=455
Donald A. Glaser	Physics	1960	USA	Bárány A. (Interviewer) & Glaser, D. A. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=710
Martinus J.G. Veltman	Physics	1999	Netherlands	Carlson P. (Interviewer) & Veltman M. (Interviewee). (1999). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=456
Robert C. Richardson	Physics	1996	USA	Griehsel M. (Interviewer) & Richardson, R. C. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=715
Nicolaas Bloembergen	Physics	981	Netherlands	Griehsel M. (Interviewer) & Bloembergen N. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=886

Douglas D. Osheroff	Physics	1996	USA	Griehsel M. (Interviewer) & Osheroff , D. D. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=714
Ivar Giaever	Physics	1973	Norway	Griehsel M. (Interviewer) & Giaever I. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=713
Carl E. Wieman	Physics	2001	USA	Smith A. (Interviewer) & Wieman, C. E. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=985
Antony Hewish	Physics	1974	United Kingdom	Smith A. (Interviewer) & Hewish A. (Interviewee). (2009). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1144
George F. Smoot	Physics	2006	USA	Smith A. (Interviewer) & Smoot, G. F. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1083
Brian D. Josephson	Physics	1973	United Kingdom	Griehsel M. (Interviewer) & Josephson, B. D. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=977
George J. Stigler	Economics	1982	USA	Stigler, G. J. (1995). George J. Stigler. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 95-112), Cambridge, MA: The MIT Press.
Sir Arthur Lewis	Economics	1979	United Kingdom	Lewis A. (1995). W. Arthur Lewis. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 1-19), Cambridge, MA: The MIT Press.
Lawrence R. Klein	Economics	1980	USA	Klein, L. R. (1995). Lawrence R. Klein. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 21-40), Cambridge, MA: The MIT Press.
Milton Friedman	Economics	1976	USA	Friedman M. (1995). Milton Friedman. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 79-93), Cambridge, MA: The MIT Press.

Paul A. Samuelson	Economics	1970	USA	Samuelson, P. A. (1995). Paul A. Samuelson. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 59-76), Cambridge, MA: The MIT Press.
Douglass C. North	Economics	1993	USA	North, D. C. (1995). Douglass C. North. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 251-267), Cambridge, MA: The MIT Press.
James M. Buchanan	Economics	1986	USA	Buchanan, J. H. (1995). James M. Buchanan. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 165-181), Cambridge, MA: The MIT Press.
Myron S. Scholes	Economics	1997	Canada	Smith A. (Interviewer) & Scholes, M. S. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1134
Daniel L. McFadden	Economics	2000	USA	Smith A. (Interviewer) & McFadden, D. L. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1132
Edmund S. Phelps	Economics	2006	USA	Bergström R. (Interviewer) & Phelps, E. S. (Interviewee). (2006). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=85
Robert C. Merton	Economics	1997	USA	Griehsel M. (Interviewer) & Merton, R. C. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=443
William F. Sharpe	Economics	1990	USA	Sharpe, W. F. (1995). William F. Sharpe. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 205-225), Cambridge, MA: The MIT Press.
John F. Nash Jr.	Economics	1994	USA	Griehsel M . (Interviewer) & Nash Jr., J. F. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=429
James A. Mirrlees	Economics	1996	United Kingdom	Griehsel M . (Interviewer) & Mirrlees, J. A. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=440
Kenneth J. Arrow	Economics	1972	USA	Arrow, K. J. (1995). Kenneth J. Arrow. In W. Breit and R. Spencer (Eds.), Lives Of Laureates - Thirteen Nobel Economists (pp. 47-57), Cambridge, MA: The MIT Press.

Robert W. Fogel	Economics	1993	USA	Griehsel M . (Interviewer) & Fogel, R. W. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=689
Fritz Lipmann	Medicine	1953	Russia	Lipmann F. (1984). A long life in times of great upheaval. Annual Review of Biochemistry, 53, 1-31.
Gertrude B. Elion	Medicine	1988	USA	Elion, G. B. (1993). The quest for a cure. Annual review of Pharmacology and Toxicology, 33, 1-22.
Arthur Kornberg	Medicine	1959	USA	Smith A. (Interviewer) & Kornberg A. (Interviewee). (2006). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=84
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Robert F. Furchgott	Medicine	1998	USA	Furchgott, R. F. (1995). A research trail over half a century. Annual review of Pharmacology and Toxicology, 35, 1-27.
Julius Axelrod	Medicine	1970	USA	Axelrod J. (1988). An unexpected life in research. Annual review of Pharmacology and Toxicology, 28, 1-23.
Konrad Bloch	Medicine	1964	Germany	Bloch K. (1987). Summing up. Annual Review of Biochemistry, 56, 1-19.
Severo Ochoa	Medicine	1959	Spain	Ochoa S. (1980). The pursuit of a hobby. Annual Review of Biochemistry, 49, 1-30.
Alan L. Hodgkin	Medicine	1963	United Kingdom	Hodgkin, A. L. (1983). Beginning: Some reminiscences of my early life. Annual Review of Physiology, 45, 1-15.
Rolf M. Zinkernagel	Medicine	1996	Switzerland	Smith A. (Interviewer) & Zinkernagel, R. M. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=982
Christian de Duve	Medicine	1974	Belgium	Orrenius S. (Interviewer) & Duve C. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=726
Rita Levi-Montalcini	Medicine	1986	Italy	Smith A. (Interviewer) & Levi-Montalcini R. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=1101
Eric R. Kandel	Medicine	2000	Austria	Smith A. (Interviewer) & Kandel, E. R. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=984

Alfred G. Gilman	Medicine	1994	USA	Smith A. (Interviewer) & Gilman , A. G. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=895
Arvid Carlsson	Medicine	2000	Sweden	Smith A. (Interviewer) & Carlsson A. (Interviewee). (2008). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=902
David Baltimore	Medicine	1975	USA	Pettersson R. (Interviewer) & Baltimore D. (Interviewee). (2001). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=172
Gerhard Herzberg	Chemistry	1971	Germany	Herzberg G. (1985). Molecular spectroscopy: A personal history. Annual Review of Physical Chemistry, 36, 1-30.
Frederick Sanger	Chemistry	1958	United Kingdom	Rose J. (Interviewer) & Sanger F. (Interviewee). (2001). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=360
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Leopold Ruzicka	Chemistry	1939	Switzerland	Ruzicka L. (1973). In the borderland between biorganic chemistry and biochemistry. Annual Review of Biochemistry, 42, 1-20.
Arne Tiselius	Chemistry	1948	Sweden	Tiselius A. (1968). Reflection from both the sides of the counter. Annual Review of Biochemistry, 37, 1-22.
Luis Leloir	Chemistry	1970	Argentina	Leloir L. (1983). Far away and long ago. Annual Review of Biochemistry, 52, 1-15.
Johann Deisenhofer	Chemistry	1988	Germany	Smith A. (Interviewer) & Deisenhofer J. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=893
Walter Kohn	Chemistry	1998	Austria	Griehsel M. (Interviewer) & Kohn W. (Interviewee). (2004). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=843
Sidney Altman	Chemistry	1989	Canada	Forsén S. (Interviewer) & Altman S. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=731
John C. Polanyi	Chemistry	1986	Canada	Forsén S. (Interviewer) & Polanyi, J. C. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=729

Manfred Eigen	Chemistry	1967	Germany	Jörnvall H. (Interviewer) & Eigen M. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=879
Kary B. Mullis	Chemistry	1993	USA	Griehsel M . (Interviewer) & Mullis , K. B. (Interviewee). (2005). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=428
Gerhard Ertl	Chemistry	2007	Germany	Smith A. (Interviewer) & Ertl, G. H. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=767
Aaron Ciechanover	Chemistry	2004	Israel	Smith A. (Interviewer) & Ciechanover A. (Interviewee). (2007). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=990
George A. Olah	Chemistry	1994	Hungary	Bárány A. (Interviewer) & Olah, G. A. (Interviewee). (2000). Retrieved from Nobelprize.org Web site: http://nobelprize.org/mediaplayer/index.php?id=733

Table 2

Items, Factor Loadings, Average Variance Extracted, and Internal Consistency

Item	Factors 1	2	3	4	5	6	7
1. Mentor Relationship (AVE=.68; Consistency =.95**)**							
...clearly understand the goals of the project with the mentor?	**0.71**	0.25	0.34	0.33	0.58	0.47	0.60
...have a high quality exchange relationship with the mentor?	**0.86**	0.33	0.11	0.44	0.51	0.53	0.51
To what extent does the scientist's mentor contribute to high feelings of self-efficacy held by the scientist?	**0.84**	0.24	0.21	0.35	0.53	0.46	0.47
…scientist's mentor aid in problem construction?	**0.77**	0.08	0.15	0.21	0.44	0.31	0.44
...have a supportive, non-controlling mentor?	**0.71**	0.39	0.13	0.43	0.38	0.44	0.46
...have open interactions with the mentor?	**0.84**	0.29	0.03	0.30	0.45	0.39	0.47
...receive evaluation from the mentor?	**0.85**	0.18	0.24	0.36	0.51	0.38	0.55
...receive informational feedback from the mentor?	**0.90**	0.16	0.21	0.38	0.59	0.45	0.61
...receive constructive feedback from the mentor?	**0.89**	0.16	0.20	0.39	0.56	0.43	0.63
2. Autonomy (AVE = .82; Consistency = .90)							
...exhibit independence of judgment?	0.29	**0.89**	0.34	0.22	0.42	0.21	0.37
To what extent is the scientist autonomous?	0.25	**0.93**	0.38	0.27	0.39	0.26	0.28
3. Personal Initiative (AVE = .70; Consistency = .82)							
...exhibit intrinsic motivation?	0.31	0.34	**0.81**	0.40	0.39	0.43	0.43
...exhibit a predisposition towards risk?	0.09	0.33	**0.86**	0.33	0.34	0.15	0.18
4. Network – Early Career (AVE=.63; Consistency =.83)							
...study with highly creative people?	0.57	0.24	0.35	**0.80**	0.60	0.56	0.57
...have access to different scientific disciplines?	0.20	0.14	0.22	**0.75**	0.26	0.48	0.35
...scientist have access to external others?	0.27	0.25	0.44	**0.83**	0.43	0.45	0.37
5. Team Climate – Early Career (AVE = .62; Consistency = .87)							
...engage in constructive task conflict?	0.38	0.16	0.28	0.38	**0.67**	0.36	0.57
...participate in decision making?	0.53	0.50	0.35	0.35	**0.88**	0.44	0.70
...have participative safety	0.46	0.38	0.36	0.48	**0.82**	0.40	0.56
To what extent do others build the creative self-confidence of the scientist?	0.63	0.32	0.37	0.52	**0.78**	0.47	0.61
6. Network – Estab Career (AVE=.64; Consistency =.84)							
...study with highly creative people?	0.56	0.15	0.27	0.50	0.56	**0.72**	0.55
...have access to different scientific disciplines?	0.30	0.19	0.18	0.39	0.29	**0.79**	0.43
...scientist have access to external others?	0.47	0.27	0.35	0.62	0.45	**0.89**	0.73
7. Team Climate – Estab Career (AVE = .74; Consistency = .92)							
...engage in constructive task conflict?	0.59	0.29	0.35	0.47	0.68	0.58	**0.88**
...participate in decision making?	0.58	0.39	0.37	0.45	0.71	0.63	**0.94**
...have participative safety	0.57	0.34	0.27	0.47	0.63	0.66	**0.89**
To what extent do others build the creative self-confidence of the scientist?	0.52	0.16	0.22	0.50	0.63	0.57	**0.71**

Note. Factor loadings are in bold. AVE = Average Variance Extracted. Consistency - Internal Consistency Reliability. Unless otherwise noted, all items begin with "To what extent does the scientist…"

Table 3

Means, Standard Deviations, Reliabilities, and Correlations.

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9
1 New Things - EarlyC	3.67	.39	**1.00**								
2 New Things - EstabC	3.76	.39	.55**	**1.00**							
3 Mentor Relationship	3.51	.33	.23	.35**	**.82**						
4 Autonomy	3.69	.29	.48**	.41**	.29*	**.90**					
5 Personal Initiative	3.73	.30	.41**	.34**	.23	.41**	**.82**				
6 Network – EC	3.60	.32	.54**	.45**	.44**	.26*	.43**	**.79**			
7 Team Climate – EC	2.74	.19	.60**	.51**	.62**	.43**	.44**	.55**	**.79**		
8 Network – EstabC	3.64	.32	.49**	.59**	.54**	.25	.35**	.63**	.54**	**.80**	
9 Team Climate – EstabC	3.54	.29	.45**	.62**	.63**	.35**	.37**	.56**	.78**	.71**	**.86**

Note: N = 59. Boldfaced values on the diagonal represent the square root of the average variance extracted (AVE). New Things = Try New Things; EarlyC = Early Career; EstabC = Established Career.
*p < .05. **p <.01

Table 4

Partial Least Squares (PLS) b-weights and Relative Importance (RI) weights

	Try New Things -Early Career			Try New Things -Estab Career		
Predictor	*b*	RI	RI as % of R^2	*b*	RI	RI as % of R^2
Autonomy	.25*	.11	19.9	.22*	.08	15.4
Personal Initiative	.04	.06	10.6	.03	.03	6.5
Mentor Relationship	.28†	.03	6.5	.12	.04	8.5
Network [a]	.32*	.19	36.6	.33*	.17	35.6
Team Climate [a]	.48*	.14	26.4	.38*	.16	34.0
Total R^2		.53	100.0		.48	100.0

Note.[a] Network and Team Climate variables represent Early Career variables for Try New Things - Early Career and Established Career variables for Try New Things – Established Career, respectively. † p < . 10. * p < .05.